A CONCEPTUAL FRAMEWORK FOR SUSTAINABLE FERTILIZER RECOMMENDATIONS:A CASE STUDY FOR ASPARAGUS

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Introduction

Sustainable crop production needs optimal nutrient management to balance high economic profitability with minimal environmental losses. Moreover, efficient use of nutrients like P, for which worlds reserves are limited, is urgent. For optimal nutrient management, fertilizer schemes should balance crop requirement with the natural soil nutrient supply. Robust, reliable and generally applicable methods to quantify soil nutrient supply are currently not available. Therefore, we developed a framework for soil supply potential using the concepts of intensity, quantity and buffering. Intensity is the amount of directly available nutrients in the soil solution, quantity is the amount that is potentially available, and buffering reflects the soils' capacity to maintain the concentration in soil solution during growing season. These concepts are put to practice using an innovative combination of standard routine soil measurements and process-based algorithms for nitrogen (Ros, 2011) and phosphorus (Van Rotterdam et al., 2012). Nutrient requirements of most annual crops can often be derived from crop yield and nutrient composition. However, other crops like sugar beets, grains or perennials also require nutrients for non-harvested crop parts. Asparagus is a perennial crop that develops structural storage roots from which asparagus spears develop at the start of the growing season, followed by an extensive shoot which fuels the roots with sugars needed for spear development in the next season. In the Netherlands, this conceptual framework will be implemented in fertilizer recommendation schemes for N and P. In this study, the conceptual framework is tested and further developed for asparagus.

Material and methods

Crop nutrient requirement in different crop stages was assessed by the nutrient uptake of roots and shoots. Fresh and dry weight of root and shoot biomass was determined (triplicate) at three dates during the growing season, in 13 fields differing in crop age (0-8 years). Nutrient and sugar concentrations were measured with standard routine techniques. Soil samples were taken at the start and at the end of the growing season and N and P soil supply were determined with the new concepts using a combination of routine soil measurements and process-based algorithms.

Results and Discussion

The total root biomass, sugar and nutrient content show an increase with crop age (Figure 1). In the year of planting, asparagus developed extensive shoot and root biomass. At the end of the first season a substantial part of the nutrients of the shoot was redistributed to the roots (Figure 1 for N and P_2O_5, other nutrients show a similar pattern). In following

years, biomass and nutrient content increased during the growing season, but no significant redistribution of nutrients from shoot to roots was observed, contrary to expectations underlying current fertilizer recommendations (Feller et al. 2011). The nutrient requirement during growing season was 110 kg N and 35 kg P_2O_5 for all crop ages. At the end of growing season, the shoot is incorporated into the soil, and the nutrients will become part of soil fractions. The soils' N supply for the different fields was determined as 70 and 265 kg N $year^{-1}$, which will mostly cover the N requirement of asparagus. The P availability was adequate to high, meaning that no P_2O_5 limitation is expected. This quantification of the soil natural nutrient supply at field level will allow for an optimization of the current fertilizer recommendations. Current fertilizers schemes for asparagus use the balance approach, in which the fertilizer need is derived from crop uptake and a very general estimate of soil supply.

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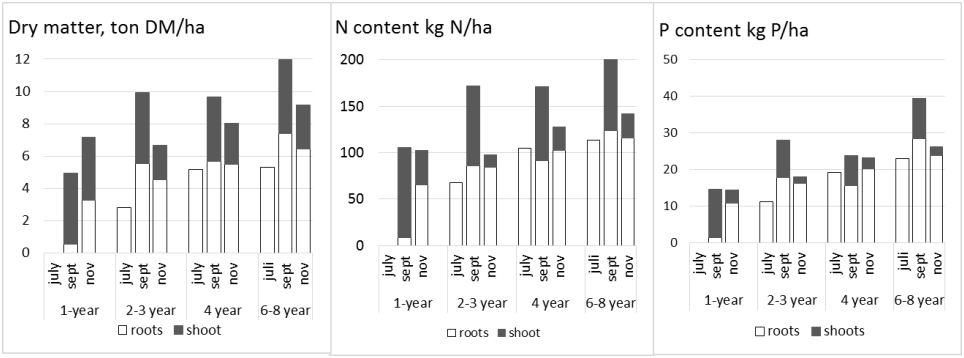
Figure 1. The dry matter, N and P uptake of asparagus crops of increasing age at three dates during growing season: directly after asparagus yield, at optimal shoot development, end of growing season.



Conclusions

The conceptual framework shows that fertilizer recommendations can be optimized by quantifying both crop uptake and soil natural nutrient supply with potentially less leaching losses.

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